

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A process for etching a silicon nitride layer with selectivity to an underlying and/or overlying dielectric layer, comprising:

introducing a semiconductor substrate into a ~~medium-density~~ plasma etching reactor, wherein the plasma reactor comprises a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which the substrate is supported, the bottom electrode being supplied RF energy at two different frequencies or the showerhead electrode being supplied RF energy at a first frequency and the bottom electrode being supplied RF energy at a second frequency which is ~~greater than~~ different from the first frequency, the semiconductor substrate having a layer of silicon nitride and the layer of silicon nitride having an underlying and/or overlying dielectric layer;

supplying etching gas to the plasma etching reactor and energizing the etching gas into a plasma state, the etching gas including CH_3F and ~~at least one oxygen reactant~~ O_2 supplied to the plasma etching reactor at a flow rate ratio of ~~oxygen reactant~~ O_2 to CH_3F of 0.65 to 1.5;

etching exposed portions of the silicon nitride layer with the plasma so as to etch openings in the silicon nitride layer with the plasma while providing an etch rate selectivity of the etching rate of the silicon nitride layer to the etching rate of the dielectric layer of at least about 10.

2. (Original) The process of claim 1, wherein the dielectric layer comprises a doped or undoped silicon oxide film.
3. (Canceled)
4. (Original) The process of claim 1, wherein the etching gas is nitrogen-free.
5. (Currently Amended) The process of claim 1, wherein the etching gas consists essentially of CH_3F , ~~oxygen~~ O_2 and optionally Ar.
6. (Original) The process of claim 1, wherein the silicon nitride layer overlies or underlies an organic low-k dielectric material.
7. (Original) The process of claim 1, wherein the openings are 0.25 micron or smaller sized openings and/or wide open trenches.
8. (Canceled)
9. (Original) The process of clam 1, wherein the etching gas includes a carrier gas selected from the group consisting of Ar, He, Ne, Kr, Xe or mixtures thereof.
10. (Canceled)

11. (Currently Amended) The process of claim 1, wherein the etching gas is nitrogen-free and the flow rate ratio of the ~~oxygen-reactant~~ O₂ to ~~fluorocarbon reactant~~ CH₃F is 1 or less.

12. (Currently Amended) The process of claim 1, wherein the ~~fluorocarbon reactant~~ CH₃F is supplied to the plasma reactor at a flow rate of 5 to 200 sccm and the ~~oxygen-reactant~~ O₂ is supplied to the plasma reactor at a flow rate of 5 to 200 sccm.

13. (Original) The process of claim 1, further comprising applying an RF bias to the semiconductor substrate during the etching step.

14. (Original) The process of claim 1, wherein the silicon nitride layer overlies an electrically conductive or semiconductive layer comprising a metal-containing layer selected from the group consisting of doped and undoped polycrystalline or single crystal silicon, aluminum or alloy thereof, copper or alloy thereof, titanium or alloy thereof, tungsten or alloy thereof, molybdenum or alloy thereof, titanium nitride, titanium silicide, tungsten silicide, cobalt silicide, and molybdenum silicide.

15. (Original) The process of claim 1, wherein the etching step is carried out as part of a process of manufacturing a damascene structure.

16. (Original) The process of claim 1, further comprising steps of forming a photoresist layer as a masking layer, patterning the photoresist layer to form a plurality of the openings and the etching step forms via or contact openings in the silicon nitride layer.

17. (Original) The process of claim 1, wherein the silicon nitride layer is between an overlying dielectric layer and an underlying copper layer, the copper layer being exposed to the plasma in the openings during the etching step.

18. (Canceled)

19. (Original) The process of claim 1, wherein the plasma reactor is at a pressure of 5 to 1000 mTorr during the etching step.

20. (Original) The process of claim 1, wherein the semiconductor substrate comprises a silicon wafer supported on a bottom electrode and the bottom electrode is maintained at a temperature of 20 to 50°C during the etching step.

21. (Currently Amended) The process of claim 1, wherein the plasma reactor pressure is at a pressure above 80 mTorr.

22. (Currently Amended) The process of claim 1, wherein the ~~fluorocarbon reactant~~ CH₃F is supplied to the plasma reactor at a flow rate of 20 to 40 sccm and the ~~oxygen reactant~~ O₂ is supplied to the plasma reactor at a flow rate of 20 to 40 sccm.

23. (Canceled)

24. (Currently Amended) A process for etching a silicon nitride layer with selectivity to an underlying and/or overlying dielectric layer, comprising:

introducing a semiconductor substrate into a ~~medium-density~~ plasma etching reactor, wherein the plasma reactor comprises a parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which the substrate is supported, the semiconductor substrate having a layer of silicon nitride and the layer of silicon nitride having an underlying and/or overlying dielectric layer;

supplying etching gas to the plasma etching reactor through the showerhead electrode and energizing the etching gas into a plasma state in a gap between the showerhead electrode~~[[]]~~ and the bottom electrode, the etching gas including CH₃F and ~~at least one oxygen reactant~~ O₂ supplied to the plasma etching reactor at a flow rate ratio of ~~oxygen reactant~~ O₂ to CH₃F of 0.65 to 1.5;

etching exposed portions of the silicon nitride layer with the plasma so as to etch openings in the silicon nitride layer with the plasma while providing an etch rate selectivity of the etching rate of the silicon nitride layer to the etching rate of the dielectric layer of at least about 10.

25. (Currently Amended) The process of claim 24, wherein the dielectric layer comprises a doped or undoped silicon oxide film, the etching gas is nitrogen-free, the etching gas consists essentially of CH_3F , ~~oxygen-reactant~~ O_2 and optionally Ar, and the silicon nitride layer overlies or underlies an organic low-k dielectric material.

26. (Currently Amended) The process of claim 24, wherein the etching gas is nitrogen-free and the flow rate ratio of the ~~oxygen-reactant~~ O_2 to ~~fluorocarbon~~ reactant CH_3F is 1 or less, the etching step is carried out as part of a process of manufacturing a damascene structure, and the process includes forming a photoresist layer as a masking layer, patterning the photoresist layer to form a plurality of the openings and the etching step forms via or contact openings in the silicon nitride layer.

27. (Previously Presented) The process of claim 24, wherein the silicon nitride layer is between an overlying dielectric layer and an underlying copper layer, the copper layer being exposed to the plasma in the openings during the etching step, the plasma reactor is at a pressure of 5 to 1000 mTorr during the etching step, and the semiconductor substrate comprises a silicon wafer supported on a bottom electrode maintained at a temperature of 20 to 50°C during the etching step.

28. (Currently Amended) The process of claim 24, wherein the plasma reactor pressure is at a pressure above 80 mTorr, the ~~fluorocarbon reactant~~ CH₃F is supplied to the plasma reactor at a flow rate of 20 to 40 sccm and the ~~oxygen reactant~~ O₂ is supplied to the plasma reactor at a flow rate of 20 to 40 sccm.

29. (Currently Amended) A process for etching a silicon nitride layer with selectivity to an underlying and/or overlying dielectric layer, comprising:

introducing a semiconductor substrate into a capacitively coupled plasma etching reactor, wherein the plasma reactor includes a showerhead electrode and a bottom electrode on which supports the substrate ~~is supported therein~~, the semiconductor substrate having a layer of silicon nitride and the layer of silicon nitride having an underlying and/or overlying dielectric layer;

supplying etching gas to the plasma etching reactor through the showerhead electrode and energizing the etching gas into a plasma state in a gap between the showerhead electrode and the bottom electrode, the etching gas ~~consisting essentially of~~ including CH₃F and ~~at least one oxygen reactant~~ O₂ supplied to the plasma etching reactor ~~at a flow rate ratio of oxygen reactant to CH₃F of 0.65 to 1.5;~~

etching exposed portions of the silicon nitride layer with the plasma so as to etch openings in the silicon nitride layer with the plasma while providing an etch rate selectivity of the etching rate of the silicon nitride layer to the etching rate of the dielectric layer of at least about ~~40~~ 5.

30. (New) The process of claim 29, wherein the capacitively coupled plasma etching reactor is at a pressure between about 30 and 200 mTorr.

31. (New) The process of claim 30, wherein the capacitively coupled plasma etching reactor is at a pressure between about 80 and 150 mTorr.

32. (New) The process of claim 29, wherein the etching gas consists essentially of CH₃F, O₂ and optionally Ar.

33. (New) The process of claim 29, wherein the CH₃F and O₂ are supplied at flow rates of 5 to 200 sccm.

34. (New) The process of claim 29, wherein the O₂ is supplied at a flow rate of 15 to 100 sccm and the CH₃F is supplied at a flow rate of 15 to 200 sccm.

35. (New) The process of claim 29, wherein the capacitively coupled plasma etching reactor is a dual frequency parallel plate plasma reactor, wherein energizing the etching gas into a plasma comprises supplying two different frequencies of RF energy to at least one parallel plate electrode in the reactor.